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Research Article

Development and characterization of a gelatin-based herbal hydrogel patch loaded with Jatropha podagrica leaf extract for antibacterial wound dressing.

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Abstract: *This study developed a hydrogel wound dressing infused with Jatropha podagrica leaf extract to evaluate its antibacterial potential. Saponin-rich extracts were obtained by ethanol extraction and solvent partitioning, then incorporated into gelatin hydrogels at varying concentrations (0–100%v/v). The antibacterial activity was assessed using the disk diffusion method. Results showed that the hydrogel with 80% extract achieved the greatest bacterial inhibition. These findings suggest that Jatropha podagrica extract enhances hydrogel efficacy, highlighting its potential as a natural antibacterial wound dressing.*

1. INTRODUCTION

At present, bacterial infections of the skin are a widespread health concern and are frequently responsible for delaying the natural wound healing process. Such infections often arise from inadequate or improper wound care, which allows bacteria to multiply rapidly at the wound site. In many cases, people underestimate the severity of small cuts or abrasions, assuming they will heal on their own without appropriate cleaning or protection. As a result, these untreated wounds may become easily exposed to harmful microorganisms, increasing the likelihood of infection and potentially leading to complications.

Additionally, some individuals experience allergic reactions or skin sensitivities to commonly used wound-care materials, such as commercial adhesive plasters or dressings. These reactions can cause discomfort, irritation, or swelling, making such dressings unsuitable for proper wound coverage.

Without a suitable barrier to protect the injured area, bacteria can enter the wound more easily and proliferate, worsening the infection and prolonging healing.

In Thailand, a wide variety of traditional medicinal plants have been recognized for their therapeutic properties, particularly for their antibacterial effects. One such plant is Jatropha podagrica, which contains Saponin—a biologically active compound known for its effectiveness in inhibiting the growth of bacterial pathogens. Due to these promising properties, the project team became interested in extracting Saponin from Jatropha podagrica leaves and incorporating it into a hydrogel sheet to examine its potential to suppress bacterial growth while also reducing skin irritation.

Hydrogel dressings have gained popularity in modern wound-care applications because they are capable of maintaining a moist healing environment, which is essential for promoting cellular repair and tissue regeneration. Furthermore, hydrogels reduce pain during removal, minimize tissue adhesion, and help lower the risk of scarring. By enriching hydrogel sheets with herbal extracts, their antibacterial performance may be enhanced while potentially reducing the adverse effects associated with synthetic chemical agents.

For these reasons, the project team initiated a scientific study entitled "Development and Characterization of a Gelatin-Based Herbal Hydrogel Patch Loaded with Jatropha podagrica Leaf Extract for Antibacterial Wound Dressing." The aim of this project is to explore the medicinal potential of Thai herbal plants and to develop a safe, effective hydrogel dressing capable of inhibiting bacterial growth. Ultimately, this study seeks to contribute to the creation of improved wound-care products that combine modern biopolymer technology with traditional herbal knowledge for future medical applications.

2. LITERATURE REVIEW

Jatropha podagrica Hook., commonly known as the Buddha Belly plant, belongs to the family Euphorbiaceae. According to the compilation by Associate Professor Dr. Duangporn Premjit, Associate Professor Dr. Siripong Premjit, Dr. Pranee Ngangam, and Dr. Pattamon Saeng-in (2014), this plant originates from Central America and Hawaii. It is commonly cultivated in tropical regions and can be found growing from sea level up to approximately 800 meters above sea level. Botanically, *Jatropha podagrica* is classified as a shrub that can grow up to approximately 2.5 meters in height. Due to its adaptability and distinctive morphology, the plant has been widely cultivated as an ornamental species and has also attracted interest for its potential phytochemical constituents.

One of the important bioactive compounds found in many plants is saponin, a group of glycoside compounds widely distributed in plant tissues. Research conducted by Chiang Mai University (2024) reported that the structure of saponins consists of two major components: a non-sugar moiety and a sugar moiety. The non-sugar component, known as aglycone, is typically composed of triterpenes or steroidal aglycones and is commonly referred to as sapogenin, while the sugar component is known as glycone, which may contain one or multiple sugar units. Saponins possess several functional properties, including the ability to produce foam and reduce surface tension. Because of these properties, they have been widely utilized in various applications such as soap production, agriculture, and the food industry. In addition, saponins exhibit significant biological activities, including antimicrobial and antifungal effects, making them a compound of interest for biomedical and pharmaceutical research.

Extraction of bioactive compounds from plant materials can be performed using several techniques, one of which is maceration. Maceration is a commonly used extraction method in which plant materials are soaked in an organic solvent to allow the target compounds to diffuse into the

solvent. The extraction process is typically conducted in a sealed container to prevent solvent evaporation and to maintain extraction efficiency. This technique is particularly useful for extracting phytochemicals such as antioxidants and other biologically active substances from plant tissues (Ruangngam, 2014).

Previous research has also investigated the phytochemical composition of *Jatropha* species. Kolawole, Jimoh, Yakubu, and Chukwuma (2017) conducted a study examining the taxonomic value of *Jatropha integerrima* Jacq. and *Jatropha podagrica* Hook. through microscopic leaf analysis and quantitative phytochemical evaluation. Their findings revealed that the leaves of *Jatropha podagrica* contain saponin at a concentration of 0.49 ± 0.02 mg/g, indicating the presence of this bioactive compound within the plant tissues.

3. METHODOLOGY

3.1. Research design

This project aims to determine the effective concentration of crude saponin extract obtained from *Jatropha podagrica* leaves that can inhibit the growth of pathogenic bacteria without causing skin irritation. The study focuses on the development and characterization of a gelatin-based herbal hydrogel patch loaded with *Jatropha podagrica* leaf extract for use as an antibacterial wound dressing.

The research methodology is divided into three main steps. First, saponin is extracted from *Jatropha podagrica* leaves using an appropriate extraction method to obtain crude saponin extract. Second, the obtained crude saponin extract is examined to evaluate its properties and antibacterial potential. Finally, the hydrogel patch is formulated using gelatin as the base material, and the efficiency of the developed hydrogel patches as antibacterial wound dressings is investigated.

3.2. Hypothesis

The crude Saponin extract from *Jatropha podagrica* leaves is able to inhibit the growth of bacteria.

3.3. Experimental variables

Independent variable: Concentration of the extract in the hydrogel patches.

Dependent variable: The hydrogel patches's effectiveness in inhibiting pathogenis bacteria.

Controlled variable: Temperature and incubation time during bacterial culture.

3.4. Procedure

Step 1: Extracting Saponin from *Jatropha podagrica* leaf.

Use *Jatropha podagrica* leaves from Ban Pong Subdistrict, Phrao District, Chiang Mai Province, Thailand.

1. Soak *Jatropha podagrica* leaves in water mixed with sodium bicarbonate for 30 minutes, then rinse with clean water.

2. Chop the *Jatropha podagrica* leaves and bake them at 60 °C until dry.

3. Soak the *Jatropha podagrica* leaves in 70% ethanol (v/v) at a ratio of 10% w/v, shaking twice a day for 10 minutes each time for 3 days. Then filter the solution using No.1 filter paper.
4. Evaporate the solvent using a distillation apparatus at 60 °C for 1-2 hours.
5. Evaporate the water using an oven at 60 °C for 48 hours.
6. Repeat steps 3-6 two more times, using the same volume of 70% ethanol (v/v).

Step 2: Examination of obtained crude Saponin extract.

1. Dissolve the crude extract in distilled water at a ratio of 10%v/v.
2. Add 2 ml of Diethyl ether to 1 ml of crude extract and 2 ml of n-Butanol to 1 ml of crude extract.
3. Collect the Diethyl ether and n-Butanol layers then evaporate the solvent using an evaporator at 50 °C for 1-2 hours.

Step 3: Forming hydrogel and studying the efficiency of hydrogel patches.

Step 3.1 Forming hydrogel patches.

1. Mix the extract with distilled water in ratios of 0%, 5%, 20%, 50%, 80% and 100% v/v.
2. Mix 5 grams of distilled water per 1 gram of gelatin, stir it well, leave it out for 5 minutes, then dissolve it using a water bath at 45 °C.
3. Mix 2 ml of gelatin per 1 ml of crude extract of each concentration.
4. Pour the gelatin mixture into the petri dish and let it set.

Step 3.2 Studying the effectiveness of hydrogel patches.

1. Collect bacteria samples from behind the member's ears using a saline soaked cotton swab, then transfer the collected samples onto an agar plate and incubate it for 3-5 days.
2. Cut the hydrogel patches into 0.4 x 0.4 squared centimeters.
3. Transfer the bacteria onto agar plates, then place the hydrogel patches on top of the agar and incubate for 3-5 days.
4. Measure the inhibition zone of bacterial inhibition using a vernier caliper.

3.5. Experimental testing

The antibacterial activity of the developed hydrogel patches was evaluated using the disc diffusion method. Bacterial samples were collected from the skin behind the ear of team members using sterile swabs. The collected samples were then spread onto nutrient agar plates to allow bacterial growth.

Hydrogel patches incorporated with crude saponin extract at different concentrations (0–100%v/v) were prepared and used for antibacterial testing. Each hydrogel sample was placed onto the surface of the inoculated agar plates. The plates were then incubated under appropriate conditions to allow bacterial growth and interaction with the hydrogel samples.

After incubation, the formation of a clear inhibition zone surrounding the hydrogel samples was observed. The diameter of the inhibition zone was measured to evaluate the antibacterial activity of the hydrogel patches at different saponin concentrations.

3.6. Data Analysis

The antibacterial effectiveness of the hydrogel patches was analyzed by measuring the inhibition zone formed around the hydrogel samples. The inhibition zone diameter was calculated by subtracting the diameter of the hydrogel sample from the total diameter of the hydrogel together with the surrounding inhibition zone.

The obtained measurements were recorded and presented in the form of data tables for comparison and analysis.

4. FINDINGS

The antibacterial activity of gelatin-based hydrogel patches loaded with *Jatropha podagrica* leaf extract was evaluated using the disc diffusion method. Hydrogel samples containing different concentrations of crude saponin extract (0–100% v/v) were tested against pathogenic bacteria collected from the skin behind the ear of the research team members.

The results showed that hydrogel patches containing the plant extract exhibited antibacterial activity, while the control group without extract showed no inhibition zone. The inhibition zone generally increased with increasing extract concentration. Among the tested formulations, the hydrogel containing 80% v/v extract demonstrated the strongest antibacterial effect.

5. DISCUSSION

The antibacterial effectiveness of hydrogel patches containing Jatropha podagrica leaf extract is presented in Table 1.

Table 1. Inhibition zone of hydrogel patches containing different concentrations of Jatropha podagrica extract

Concentration (%v/v)	Hydrogel diameter (mm)	Hydrogel diameter and inhibition zone (mm)	Inhibition zone (mm)
0	**1.57±0.16**	**1.57±0.16**	**0**
5	**1.33±0.25**	**1.55±0.26**	**0.23±0.08**
20	**1.46±0.20**	**1.98±0.08**	**0.52±0.14**
50	**1.41±0.09**	**2.22±0.18**	**0.85±0.13**

Based on Table 1, hydrogel patches containing 80%v/v extract produced the largest inhibition zone, indicating the highest antibacterial activity among the tested formulations. The hydrogel containing 100%v/v extract also showed strong antibacterial effects, although the inhibition zone was slightly smaller.

Lower concentrations of the extract resulted in smaller inhibition zones, suggesting that antibacterial activity depends on the amount of bioactive compounds present in the hydrogel formulation. The absence of inhibition in the 0%v/v group confirms that the antibacterial activity observed in other groups was due to the presence of Jatropha podagrica extract.

The antibacterial activity observed in this study is likely related to saponins, which are known to possess antimicrobial properties. These compounds can disrupt bacterial cell membranes, leading to inhibition of bacterial growth. Therefore, incorporating Jatropha podagrica extract into gelatin-based hydrogel patches may enhance their potential application as antibacterial wound dressings.

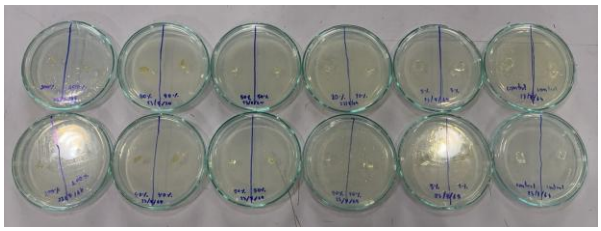

Figure 1. Agar plate with hydrogel patches immediately after placement.

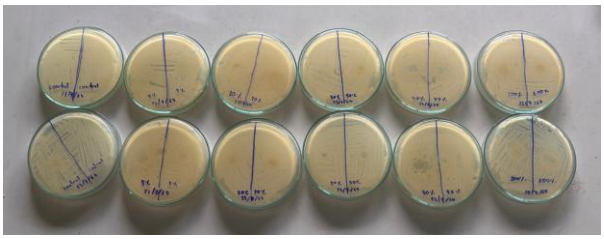

Figure 2. Agar plate with hydrogel patches after 5 days.

6. CONCLUSION

From testing the antibacterial effectiveness of the hydrogel sheet mixed with crude extract from *Jatropha podagrica* leaves, it was found that the 80%v/v concentration had the greatest ability to inhibit the growth of pathogenic bacteria, producing an inhibition zone of 1.82 ± 0.32 mm. The next most effective was the 100%v/v concentration, with an inhibition zone of 1.70 ± 0.10 mm.

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